

Foit-Albert Associate  
Architecture, Engineering and  
Surveying, P.C.

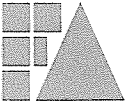
T. DIETZBACH,  
763 Main Street  
Buffalo, New York 14203-1395

Tel 716-856-3933  
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July 25, 1996

RECEIVED

JUL 26 1996



Mr. Peter J. Buechi, P.E.  
New York State Department of Environmental Conservation  
Division of Hazardous Waste Remediation  
270 Michigan Avenue  
Buffalo, New York 14203-2999

NYSDEC-REG. 9  
FOIL  
☒ REL ☐ UNREL

Re: Revised Remedial Plan  
The Former LTV (Republic Steel) Property  
1205 South Park Avenue

Dear Mr. Buechi:

On behalf of the City of Buffalo, Foit-Albert Associates, P.C. (Foit-Albert) is herein submitting the Revised Remedial Plan to the New York State Department of Environmental Conservation (NYSDEC) for petroleum-contaminated soil at the former LTV (Republic Steel) Site. Changes subsequent to NYSDEC's initial review and comments of June 26, 1996 have been made.

The City of Buffalo requests approval from NYSDEC on this Revised Remedial Plan, in order that we may finalize plans and specifications for the site's remediation. Accordingly, we appreciate your department's timely comments on this revised plan.

If you have any questions or wish to discuss this plan, please contact our office.

Sincerely,

FOIT-ALBERT ASSOCIATES  
ARCHITECTURE, ENGINEERING AND SURVEYING, P.C.

*Muffett Mauche George*

Muffett Mauche George, P.E.  
Project Manager

MMG:mg:96002.01\buechi3.rev  
Enc.

cc: Mr. Edward D. Peace, Esq., Corporation Council - City of Buffalo  
Mr. David K. Sengbusch, Director of Development - City of Buffalo

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## **PROPOSED REMEDIAL PLAN SOIL BIOREMEDIATION**

**FORMER LTV (REPUBLIC STEEL) SITE  
1205 SOUTH PARK AVENUE  
BUFFALO, NEW YORK**

### **PETROLEUM-CONTAMINATED SOIL DATA:**

Refer to Figure 1 for Site Location Map and Figure 2 for Site Plan.

Estimated Volume:	32,650 cubic yards
Approximate Area:	115,844 square feet
Depth of contaminated zone:	7.25 feet average
Depth to contamination:	0 feet to 8 feet below ground surface
Soil Type:	Slag, Clayey Silt and Sand

### **EXCAVATION CONFIRMATORY SAMPLING:**

The CONTRACTOR shall excavate all petroleum-contaminated soil at the site to the satisfaction of the NYSDEC. The basis for removal of petroleum-contaminated soil is protection against objectionable nuisance characteristics (i.e. petroleum-type odors and visual staining).

Once removal of petroleum-contaminated soil has been completed to the satisfaction of the NYSDEC, based on petroleum-type odors and visual staining, the CONTRACTOR shall take excavation confirmatory samples, according to the following schedule:

Grab soil sample of side walls along perimeter of excavation:  
1 per 100 feet of perimeter length

Composite soil sample from the bottom excavation:  
1 per 5,000 square feet of excavation (approximately 8-9 per acre)

Analytical results from direct soil analysis on excavation confirmatory samples must be less than or equal to the Toxicity Characteristic Leaching Procedure (TCLP) Alternative Guidance Values listed in NYSDEC "Spill Technology and Remediation Series Memo #1, Petroleum Contaminated Soil Guidance Policy", dated August, 1992 (hereinafter STARS Guidance Policy).

The CONTRACTOR shall not backfill the excavation until analytical results are reported to, and approved by, the NYSDEC. If excavation confirmatory analysis reveals levels of constituents which exceed these guidance values, additional excavation and confirmatory sample analysis will be required.

The CONTRACTOR may not temporarily stage excavated soils at the Former LTV site. Excavation activities may be staged to allow partial backfill of excavation, after completion and acceptance of excavation confirmatory sampling.

### **ANALYTICAL METHODS:**

Soil samples shall be analyzed directly for the primary gasoline and fuel oil components, of concern by United States Environmental Protection Agency (USEPA) Test Methods 8021 for volatile organic compounds and Test Method 8270 semi-volatile organic compounds (Base/Neutrals only) as listed in STARS Guidance Policy. No analysis on TCLP extraction will be necessary.

The laboratory chosen for the analytical work will be an approved New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified analytical testing laboratory. The CONTRACTOR should select the sample turn-around time to ensure rapid completion of excavation work.

The CONTRACTOR will provide a copy of the chosen laboratory's certifications to the ENGINEER for approval prior to performance of any analytical work.

### **SAMPLING TECHNIQUES:**

The CONTRACTOR shall follow NYSDEC Sampling Guidelines and Protocols manual for sample collection. All sampling equipment must be decontaminated between sample locations. Samples shall be placed into precleaned, labeled containers and transported to a NYSDOH approved analytical laboratory for testing. Samples will be transported in coolers under strict chain-of-custody protocol.

The CONTRACTOR shall use precleaned, appropriate sample containers and shall obtain the required sample volume for each analysis.

Proper sample preservation shall be completed by the CONTRACTOR. Sample holding times shall not be exceeded.

Sample chain-of-custody forms shall be maintained for submittal to the ENGINEER, along with analytical results of excavation confirmatory sampling.

### **ENGINEERING CONTROLS:**

The CONTRACTOR shall install sheet piling along the Buffalo River in order to facilitate excavation of petroleum-contaminated soil along the Buffalo River.

Dewatering of excavations during excavation of petroleum-contaminated soil and USTs removal will may be required. CONTRACTOR must show that water meets Groundwater Standards before discharge directly at the site or to the Buffalo River. No discharge of water to the sanitary sewer system will be allowed without prior approval from the Buffalo Sewer Authority.

## **REMOVAL OF UNDERGROUND STORAGE TANKS:**

The CONTRACTOR shall remove all USTs at the site. A total of three (3) underground storage tanks (USTs) are assumed to still exist at the site; two (2) 4,000-gallon diesel fuel USTs in the center of the site and one (1) 1,000-gallon fuel oil UST near the Truscon Building office.

The Subsurface Investigation revealed an area of fill material, evident of a tank pit, in the probable location of the two (2) 4,000-gallon USTs in the center of the site. Due to field conditions, it was impossible for Foit-Albert to positively determine existence of the two USTs.

An area of petroleum-contaminated soil was delineated in the area of the two (2) USTs. Lateral extent of the contamination in this area is approximately 21,685 square feet with vertical extent of contamination at 2.5 feet. Total estimated volume of petroleum-contaminated soil in this area is 2,125 cubic yards.

For all UST removals, excavation soil sampling will be completed in accordance with the STARS Guidance Policy, Section VI, Sampling for Tank Pits. Analytical results from direct soil analysis on excavation confirmatory samples must meet the TCLP Alternative Guidance Values for gasoline and fuel oil constituents, as stated in the STARS Guidance Policy. The CONTRACTOR shall not backfill the tank pit excavations until analytical results are reported to, and approved by, the NYSDEC. If excavation confirmatory analysis reveals levels of constituents above guidance values, additional excavation and confirmatory sample analysis will be required.

Contaminated soil encountered during tank removal will be transported to the designated off-site location and bioremediated with the petroleum-contaminated soil. Proper closure will include tank removal, residual tank liquid removal and proper disposal, tank cleaning, tank bottoms removal and proper disposal, tank decommissioning, and backfilling of tank pit. The CONTRACTOR shall file all proper waste manifests when disposing of residual tank liquids and tank bottoms. When transporting all petroleum-contaminated waste materials, the CONTRACTOR must comply with 6 NYCRR Part 364 regulations.

The ENGINEER will document all UST removals with the NYSDEC on behalf of the City of Buffalo.

## **EX-SITU BIOREMEDIATION:**

The CONTRACTOR will use an off-site location designated by the City of Buffalo for the ex-situ bioremediation. The City of Buffalo will enter into an agreement with the site owner for use of the property. When transporting petroleum-contaminated soil, the CONTRACTOR must comply with 6 NYCRR Part 364 regulations. The CONTRACTOR will be responsible for maintaining and protecting traffic during all transportation operations.

Formal permitting for use of the off-site location for ex-situ bioremediation will not be required by the NYSDEC. However, the petroleum-contaminated soil will be managed by the CONTRACTOR in accordance with provisions under 6 NYCRR Part 360.

Preparation of the site will include access road construction and construction of a pad for the bioremediation.

The CONTRACTOR shall use a bioaugmentation process, proven to successfully metabolize fuel oil and diesel fuel compounds. As a requirement of the OWNER, the CONTRACTOR must demonstrate completion of at least one fuel oil bioremediation project with a *minimum* of 15,000 cubic yards of contaminated material.

#### **BIOREMEDIATION PAD:**

In order to establish baseline values, prior to placement the bioremediation pad or any petroleum-contaminated soil at the designated off-site location, the City of Buffalo will obtain soil samples of the portion of the site to be used during bioremediation. Surface soil samples will be taken one (1) per acre and will be composited over the acre. Sample analysis for Target Compound List analytes will be completed. Analytical results will be maintained by the City of Buffalo. A copy of the analytical results of baseline sampling will be provided to the NYSDEC.

Bioremediation pad (or biopad) will be designed as a continuous layer of low permeability soil, and constructed to control fluid migration. The biopad will have a maximum remolded coefficient of permeability of  $1 \times 10^{-7}$  centimeters per second throughout its thickness. A clay and geosynthetic composite liner will be specified. Design considerations will include off-site location conditions, available acreage for pad construction and anticipated loading on the pad. Biopad construction requirements will be specified.

Biopad will be designed to allow for collection of stormwater including, but not limited to, sloped liner with collection system. Stormwater discharge from the biopad will not be allowed will be at the off-site location. Stipulations on temporary storage and reuse of stormwater from biopad will be placed on the CONTRACTOR.

A berm will be constructed around the perimeter of the biopad to ensure control of fluid migration and containment of runoff.

#### **BIOREMEDIATION MONITORING:**

##### **Quarterly reporting (throughout treatment process):**

The CONTRACTOR shall perform monthly monitoring of the bioremediation process. Quarterly reporting to the ENGINEER and the NYSDEC includes:

- pH and moisture content,
- nutrient testing, and
- qualitative test for objectional nuisance characteristics

Occasional sampling for bacterial identification and enumeration may be required by the NYSDEC or the ENGINEER, based on progress of the bioremediation process.

#### **Closure sampling:**

Once bioremediation of petroleum-contaminated soil has been completed to the satisfaction of the NYSDEC and the ENGINEER, based on petroleum-type odors and visual staining, the CONTRACTOR shall take closure confirmatory samples, according to the following schedule:

Grab soil sample:

1 per 3,000 cubic yards of soil being actively treated

Composite soil sample:

1 per 1,000 cubic yards of soil being actively treated

Closure confirmatory sampling shall be taken at grid locations across the soil pile and at representative depths within the soil pile (depending on thickness of the soil being actively treated) as approved by the NYSDEC and the ENGINEER.

Analytical results from direct soil analysis on closure confirmatory samples must meet the TCLP Alternative Guidance Values for gasoline and fuel oil components of concern as stated in the STARS Guidance Policy. The CONTRACTOR shall not remove any soil from the remediation site until closure sampling results are reported to, and approved by, the NYSDEC. If closure sample analysis reveals levels of constituents above guidance values, additional bioremediation and sample analysis will be required.

#### **DISPOSAL OF DECONTAMINATED SOIL:**

Decontaminated soil will be determined by meeting the TCLP Alternative Guidance Values stated in the STARS Guidance Policy for gasoline and fuel oil contaminated soil. The NYSDEC Regional Spill Supervisor or his/her designee will review all appropriate soil sampling data to determine if the criteria been met for reuse off-site. Upon approval from the NYSDEC, the CONTRACTOR will transport the soil to a site owned by the City of Buffalo, within a five (5) mile radius of the designated off-site bioremediation location, for reuse as fill material. The City of Buffalo will maintain all field data, laboratory results, and final deposition records for three (3) years.

The City of Buffalo may also consider reuse under a specific Beneficial Use Determination (BUD). Whichever reuse option is chosen for the material, the STARS Guidance Policy criteria will be met for that reuse option.

## **PERMITS:**

The CONTRACTOR shall comply with requirements for all permits including, but not limited to, the following:

### **U.S. Army Corps of Engineers (COE) Permits:**

The City of Buffalo will coordinate with the COE to obtain all permits required for work at the site. These permits include, but are not limited to, Section 404 Clean Water Act Permit and Section 10 Rivers and Harbors Act Permit.

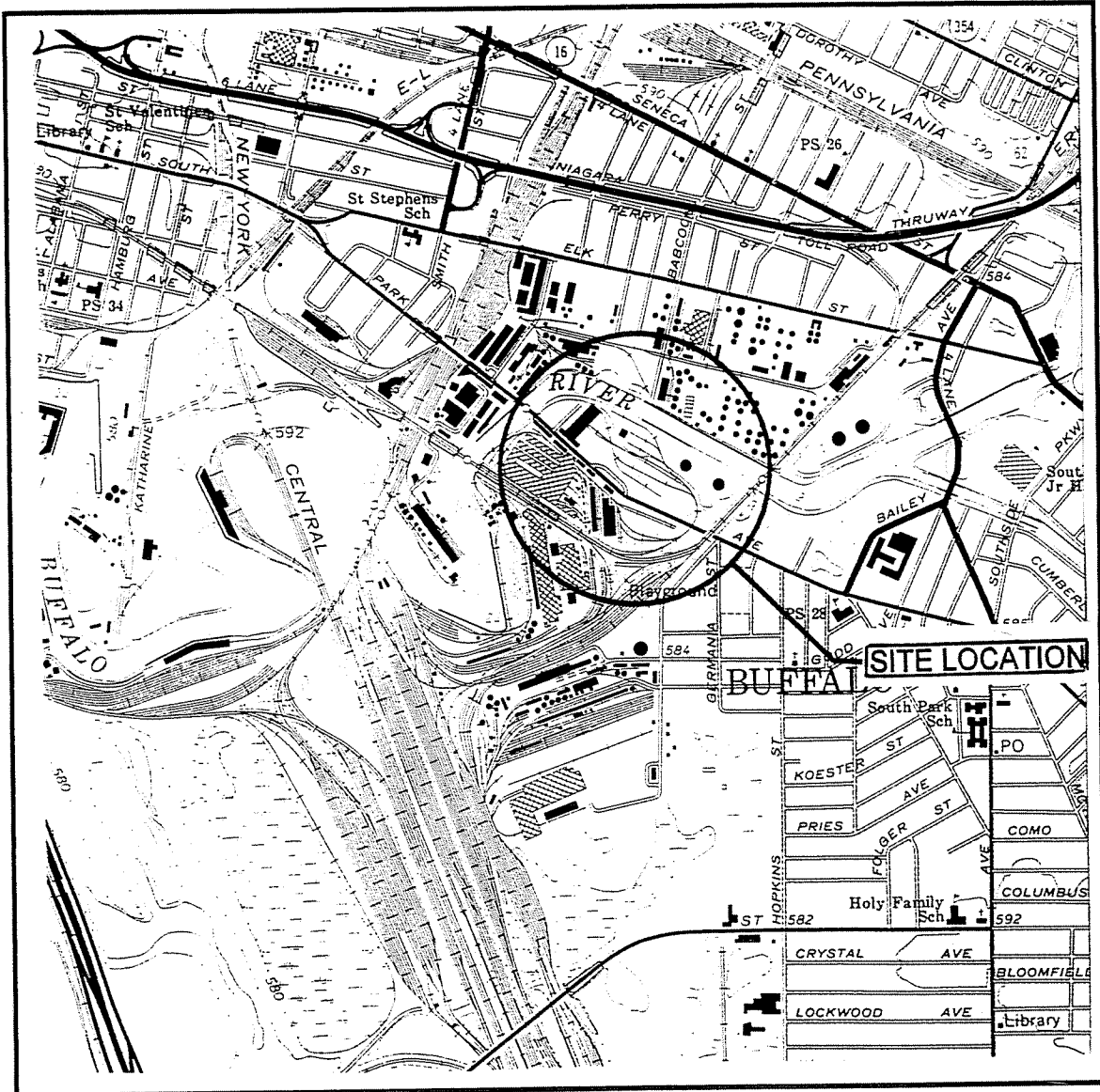
### **NYSDEC Permits:**

The City of Buffalo will coordinate with the NYSDEC to obtain all permits required for work at the site. These permits include, but are not limited to, Air Quality Permits and Water Quality Certification.

If required by the NYSDEC, air monitoring and air quality sampling will be completed by the CONTRACTOR. This may include set up of air monitoring stations at the biopad during bioremediation and at the former LTV Site during excavation of petroleum-contaminated soil, depending on permit applicability and permit requirements.

Based on review of existing analytical data, a maximum air emissions rate of 0.093 lb/hr of benzene is anticipated.

If applicable, the CONTRACTOR shall apply for and comply with a State Pollution Discharge Elimination System (SPDES) General Permit, pursuant to the NYSDEC SPDES program. If required, the CONTRACTOR shall prepare and comply with a Storm Water Pollution Prevention Plan for the duration of all construction activities.



BUFFALO SE, N. Y.  
SE/4 BUFFALO 15' QUADRANGLE  
N4245—W7845/7.5

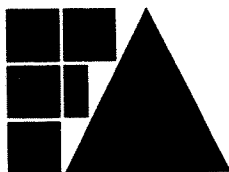
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AMS 5269 IV SE—SERIES V821

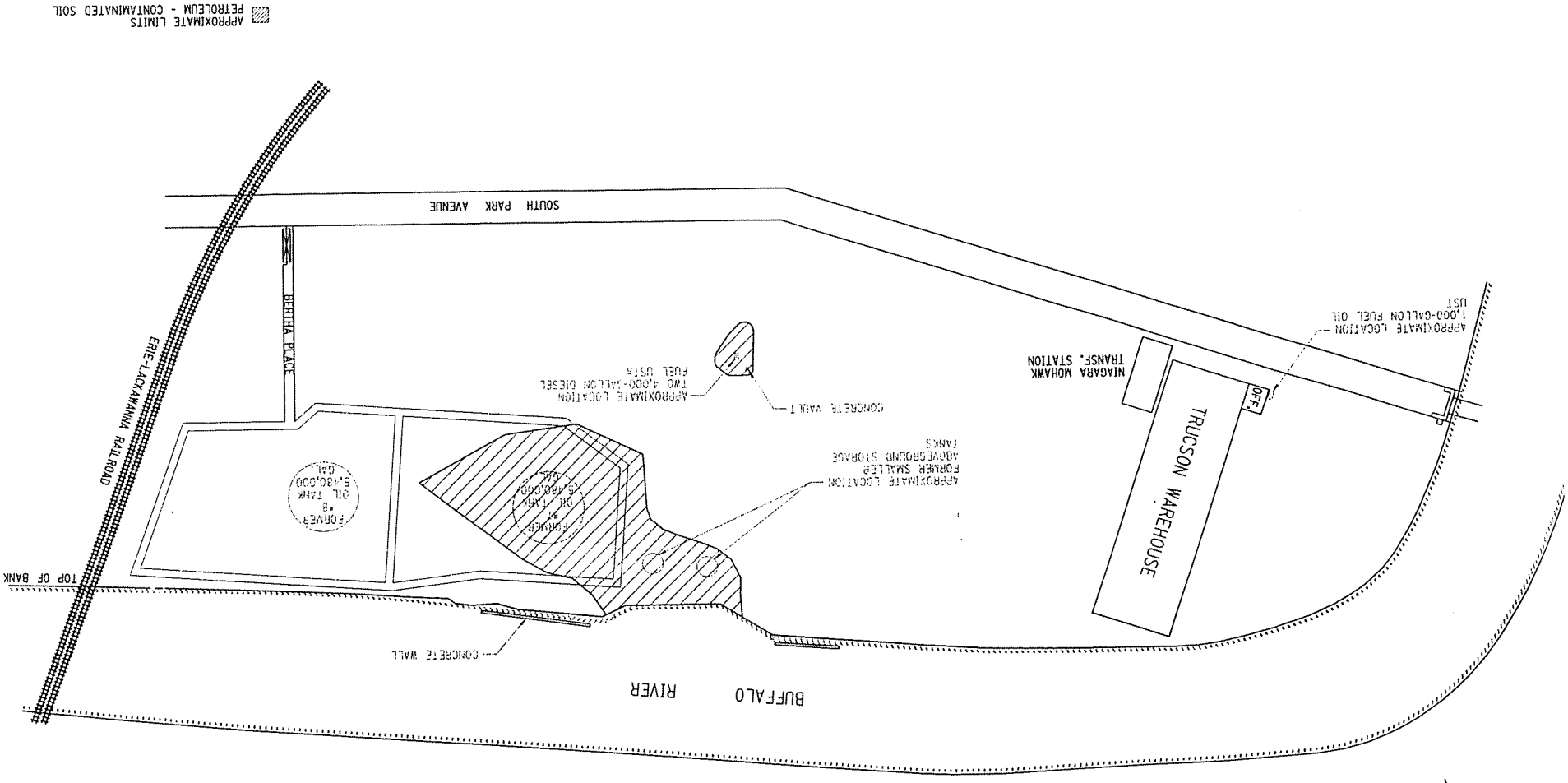
# FIGURE 1

## SITE LOCATION MAP

SCALE: 1:24,000



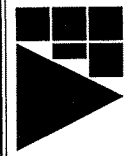
**Foit-Albert Associates**  
Architecture, Engineering and Surveying, P.C.  
763 Main Street  
Buffalo, New York 14203



SCALE: 1" = 200'

96002.01

FIGURE 2  
SITE PLAN  
FORMER LTV SITE  
REMEDIAL PLAN  
CITY OF BUFFALO  
NEW YORK



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JOB LTV Site Soil Bioremediation  
SHEET NO. 1 OF 8

CALCULATED BY mmg DATE 6/26/96  
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**COPY**

AIR EMISSION ESTIMATION \*

$$J = D_{eff} \left( \frac{dc}{dz} \right) \quad \text{Egn (B-1)}$$

$J$  = flux of vapors [lb/(ft<sup>2</sup>-hr)]

$D_{eff}$  = effective diffusion coefficient [ft<sup>2</sup>/hr]

$\left( \frac{dc}{dz} \right)$  = concentration gradient in vertical direction [lb/ft<sup>4</sup>]

$$D_{eff} = D_{air} \tau \theta_{air} \quad \text{Egn (B-2)}$$

$D_{air}$  = diffusion coefficient [ft<sup>2</sup>/hr]

$\tau$  = tortuosity ( $0 < \tau < 1$ ) [dimensionless]

$\theta_{air}$  = air filled porosity [dimensionless]

\* Per USEPA "Procedures for Estimating Air Emissions from Petroleum Underground Storage Tank Cleanups"



JOB LTV Site Soil Bioremediation

SHEET NO. 2 OF 8

CALCULATED BY mmg DATE 6/26/96

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$$\tau = (\Theta_{\text{air}})^{1/3} \left[ \frac{\Theta_{\text{air}}}{\Theta_{\text{total}}} \right]^2 \quad \text{Eqn (B-3)}$$

$$\Theta_{\text{total}} = \text{total porosity} \quad (0 < \Theta_{\text{total}} < 1)$$

$$\Theta_{\text{air}} = \text{air filled porosity}$$

$$= \Theta_{\text{total}} - \Theta_{\text{water}}$$

where  $\Theta_{\text{water}}$  = moisture content of the soil.

The steady state form of the concentration gradient -

$$\frac{dc}{dz} = (C_{\text{soil gas}} - C_{\text{atm}}) / z \quad \text{Eqn (B-4)}$$

$$C_{\text{soil gas}} = \text{concentration of contaminant in soil pores} \left( \frac{\text{lb}}{\text{ft}^3} \right)$$

$$C_{\text{atm}} = \text{concentration of contaminant in air above soil pile}$$

$$z = \text{depth of soil over which concentration gradient exists.}$$

Assume  $C_{\text{atm}} = 0$  to obtain max flux.

$$ER = J \times A$$

$$ER = \text{Emission Rate}$$

$$J = \text{vapor flux}$$

$$A = \text{surface area of soil pile}$$



JOB LTV Site Bioremediation.

SHEET NO. 3 OF 5

CALCULATED BY mmg DATE 7/23/96

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SCALE \_\_\_\_\_

Calculate soil gas concentrations from total soil concentration:

$$C_{total} = C_{gas} + C_{moisture} + C_{soil}$$

$$C_{gas} = C_{total} - C_{moisture} - C_{soil} \quad (\text{Eqn C-3})$$

$$\frac{C_{gas} \text{ (atm)}}{C_{moisture} \text{ (g/m}^3\text{)}} = \frac{H \text{ (atm} \cdot \text{m}^3/\text{mol)}}{MW \text{ (g/mol)}} \quad (\text{Eqn C-4})$$

$$\frac{C_{soil} \text{ (mg/kg)}}{C_{moisture} \text{ (g/m}^3\text{)}} = (f_{oc}) K_{oc} [1/\text{kg}] \quad (\text{Eqn C-5})$$

$$\frac{C_{soil} \text{ (mg/kg)}}{C_{gas} \text{ (atm)}} = \frac{f_{oc} K_{oc} (1/\text{kg}) MW \text{ (g/mol)}}{H \text{ (atm} \cdot \text{m}^3/\text{mol)}} \quad (\text{Eqn C-6})$$

$$1 = \frac{C_{gas}}{C_{gas}} = \frac{C_{total}}{C_{gas}} - \frac{C_{moisture}}{C_{gas}} - \frac{C_{soil}}{C_{gas}} \quad (\text{C-7})$$

For Benzene: MW = 78.11 g/mol

$C_6H_6$

@ 20°C

$$H = 5.59 \times 10^{-3} \text{ atm} \cdot \text{m}^3/\text{mol}$$

$$K_{oc} = 8.30 \times 10^1 \text{ ml/g} = \frac{1 \text{ l}}{1000 \text{ ml}} \times \frac{1000 \text{ g}}{\text{kg}} = 83 \text{ l/kg}$$

$$K_{ow} = 1.32 \times 10^2$$



JOB LTV Site Bioremediation  
SHEET NO. 6 OF 3

CALCULATED BY mmg DATE 7/23/96  
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SCALE \_\_\_\_\_

$$\text{Range } C_{\text{gas}} = 3.70 \times 10^{-7} \text{ to } 30.09 \times 10^{-7}$$

$$\text{worst case is } C_{\text{total}} = 0.391 \text{ mg/kg is all } C_{\text{gas}}$$

$$\therefore \text{use } C_{\text{gas}} = 0.391 \text{ mg/kg} \Rightarrow 1.26 \times 10^{-4} \frac{\text{lb}}{\text{ft}^3}$$

$$1) \quad \frac{dc}{dz} = (C_{\text{soil gas}} - C_{\text{atmosphere}}) / z \quad (\text{Eqn B-4})$$

$$\text{assume } C_{\text{atmosphere}} = 0$$

$$z = 0.5'' = 0.0417'$$

$$\text{Concentration of contaminants in soil pores } \left( \frac{\text{lb}}{\text{ft}^3} \right) = 1.26 \times 10^{-4}$$

$$\frac{dc}{dz} = 1.26 \times 10^{-4} \frac{\text{lb}}{\text{ft}^3} / 0.0417' = 3.02 \times 10^{-3} \frac{\text{lb}}{\text{ft}^4}$$

$$2) \quad \tau = (\theta_{\text{air}})^{1/3} \left[ \frac{\theta_{\text{air}}^2}{\theta_{\text{total}}} \right] \quad (\text{Eqn B-4})$$

$$\theta_{\text{total}} = \text{total porosity} \quad (0 < \theta_{\text{total}} < 1)$$

$$\theta_{\text{total}} = 0.30 \quad \text{from (p. 5)}$$

$$\theta_{\text{air}} = \theta_{\text{total}} - \theta_{\text{water}} = 0.30 - 0.27 = 0.03$$

$$\tau = (0.03)^{1/3} \left( \frac{0.03}{0.30} \right)^2 = 3.11 \times 10^{-3}$$



JOB LTV Site Remediation  
SHEET NO. 4 OF 8

CALCULATED BY Tommy DATE 7/25/96  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_  
SCALE \_\_\_\_\_

$$\frac{C_{\text{gas}} (\text{atm})}{C_{\text{moisture}} (\text{g/m}^3)} = \frac{H (\text{atm} \cdot \text{m}^3/\text{mol})}{MW (\text{g/mol})}$$

$$= \frac{5.59 \times 10^{-3} \text{ atm} \cdot \text{m}^3/\text{mol}}{78.11 (\text{g/mol})}$$

$$= 7.157 \times 10^{-5}$$

$$\frac{C_{\text{moisture}}}{C_{\text{gas}}} = 13,973.2$$

Try different values  $f_{oc}$   
to obtain range of  
values for  $C_{\text{gas}}$  →

$$\frac{C_{\text{soil}}}{C_{\text{gas}}} = f_{oc} K_{oc} MW/H$$

Assume  $f_{oc} = 0.10$

$$= 0.10 \times 83 \times 78.11 / 5.59 \times 10^{-3}$$

$$= 115,977$$

$f_{oc}$	$\frac{C_{\text{soil}}}{C_{\text{gas}}}$
0.10	115,977
0.50	579,886
0.90	1,043,796

From Eqn C-\*

$$1 = \frac{C_{\text{total}}}{C_{\text{gas}}} - 13,973 - 115,977$$

$$C_{\text{total}} = 391 \text{ ug/kg}$$

$$= 0.391 \text{ mg/kg}$$

Based on review of  
historical analytical data  
at LTV Site, highest  
benzene contaminant  
concentration in  
Sample TP-8  
(Enasco 11/94)

$$1 = \frac{0.391}{C_{\text{gas}}} - 13,973 - 115,977$$

$$\frac{0.391}{C_{\text{gas}}} = 129,951$$

Range =  $30.09 \times 10^{-7}$  to  $3.70 \times 10^{-7}$

$C_{\text{gas}}$



JOB LTV Site Soil Bioremediation  
SHEET NO. 5 OF 8

CALCULATED BY mmg DATE 6/27/96  
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SCALE \_\_\_\_\_

Based on review of historical analytical data:

Highest contaminant concentration in sample TP-3 (Enasco 11/94)

$$\begin{aligned}\text{Total conc. (8021 constituents)} &= 73,608 \text{ ug/Kg} \\ 73,608 \text{ ug/kg} &= 73.61 \text{ mg/kg}\end{aligned}$$

$$\text{Total conc. (benzene)} = 391 \text{ ug/kg} = 0.391 \text{ mg/kg}$$

Sample was composited over entire depth:

			<u>e*</u>
1/5 topsoil	(OL)	$\rho_d = 90 \text{ lbm/ft}^3$ **	0.65
2/5 slag	(GW)	$\rho_d = 135 \text{ lbm/ft}^3$ **	0.3
2/5 clayey silt	(ML)	$\rho_d = 108 \text{ lbm/ft}^3$ **	0.45

↑  
Soil class  
group

$$\begin{aligned}\rho_d^{\text{Dry}} \text{ Unit weight of sample} &= .2(90) + .4(135) + .4(108) \\ &\approx 115 \text{ lbm/ft}^3\end{aligned}$$

Sample was 73% solids → 27% liquids  
(by weight)

$$w = .27 \Rightarrow \boxed{\Theta_{\text{water}} = .27}$$

$$\rho = \rho_d (1+w) = 115 (1.27) \approx 146 \text{ lbm/ft}^3$$

$$\text{Void ratio (}\bar{e}\text{)} = .2(.65) + .4(0.3) + .4(0.45) = 0.43$$

$$\text{porosity (}m\text{)} = \frac{e}{1+e} = \frac{.43}{1.43} = 0.30 \Rightarrow \boxed{\Theta_{\text{total}} = 0.30}$$

$$0.391 \frac{\text{mg}}{\text{kg}} \times \frac{1 \text{ kg}}{1,000,000 \text{ mg}} \times \frac{1 \text{ lb}}{.4536 \text{ kg}} = 8.62 \times 10^{-7} \frac{\text{lb}}{\text{kg}}$$

$$8.62 \times 10^{-7} \frac{\text{lb}}{\text{kg}} \times \frac{1 \text{ kg}}{2.205 \text{ lb}} \times \frac{146 \text{ lbm}}{\text{ft}^3}$$

$$C_{\text{total}} = 1.26 \times 10^{-4} \frac{\text{lb}}{\text{ft}^3}$$

\* e Values from Principles of Foundation Engineering, Braja M. Das, 1984

\*\*  $\rho_d$  Values from Civil Engineering Reference Manual, Sixth Edition  
Michael R. Lindeburg, P.E., 1992



JOB LTV Site Bioremediation  
SHEET NO. 7 OF 9

CALCULATED BY mmj DATE 7/24/96  
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$$3) \quad D_{eff} = D_{air} \tau \theta_{air} \quad (Eqn B-2)$$

$$D_{air} = 0.0905 \text{ cm}^2/\text{sec} \quad (\text{Benzene @ } 20^\circ\text{C} \text{ Table p A-5})$$

$$0.0905 \frac{\text{cm}^2}{\text{sec}} \times \frac{1 \text{ in}^2}{2.54^2 \text{ cm}^2} \times \frac{1 \text{ ft}^2}{12^2 \text{ in}^2} \times \frac{60 \text{ sec}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}}$$

$$= 0.35 \frac{\text{ft}^2}{\text{hr}}$$

$$D_{eff} = 0.035 \frac{\text{ft}^2}{\text{hr}} \times 3.11 \times 10^{-3} \times 0.03$$

$$D_{eff} = 3.27 \times 10^{-5} \frac{\text{ft}^2}{\text{hr}}$$

$$4) \quad J = D_{eff} \left( \frac{dc}{dz} \right) \quad (Eqn B-1)$$

$$= \left( 3.27 \times 10^{-5} \frac{\text{ft}^2}{\text{hr}} \right) \left( 3.02 \times 10^{-3} \frac{\text{lb}}{\text{ft}^3} \right) \quad \left[ \frac{\text{lb}}{(\text{ft}^2 \cdot \text{hr})} \right]$$

$$J = 9.88 \times 10^{-8} \text{ lb}/(\text{ft}^2 \cdot \text{hr})$$

$$5) \quad ER = J \times A \quad (Eqn B-6)$$

$$ER_{max} = 9.88 \times 10^{-8} \left[ \frac{\text{lb}}{(\text{ft}^2 \cdot \text{hr})} \right] \times 938,925 \text{ ft}^2$$

For benzene :

$$ER_{max} = 0.093 \frac{\text{lb}}{\text{hr}}$$



JOB LTV Site Bioremediation

SHEET NO. 8 OF 8

CALCULATED BY mme DATE 6/24/96

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

SCALE \_\_\_\_\_

$$\begin{aligned} \text{Contaminated Soil} &= 34,775 \text{ CY} && (\text{estimated}) \\ &= 938,925 \text{ CF} \end{aligned}$$

$$@ 1' \text{ thickness (min)} = 938,925 \text{ SF}$$

$$@ 1.5' \text{ thickness} = 625,950 \text{ SF}$$

$$@ 4.5' \text{ thickness (max)} = 208,650 \text{ SF}$$



**Foit-Albert Associates**  
Architecture, Engineering and Surveying, P.C.

JOB

LTV Site

SHEET NO.

OF

CALCULATED BY mmg

DATE 6/18/96

CHECKED BY

DATE

SCALE

Analytical Data Summary

SAMPLE ID	DATE	BENZENE		LEAD	
		8021	8021 TCLP 8021	8240	TOTAL mg/kg
TP-5A (0.7'-2.2')	8/91			8 J	24
TP-5B (4.0'-5.4')	8/91			30	
TP-6	11/94	< 313			< 0.132
TP-7	11/94	391			< 0.132
TP-8	11/94	< 313			< 0.132
TP-9	11/94	< 625			< 0.132
TP-10	11/94	< 625			< 0.132
TP-11	11/94	< 625			< 0.132
TP-12	1/95	< 2.5			< 0.132
TP-17	1/95	< 2.5			< 0.132
TP-21	1/95	< 2.5			0.186
TP-23	1/95	< 2.5			< 0.132
TP-25 (A <sub>90</sub> )	1/95	—			—
B-8	1/96	< 100			
B-9	1/96	< 3			
		10,000 ppb	5 ppm in extract 500 ppb in extract		5 mg/L